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Adoption of Good Agricultural Practice (VietGAP) in the Lychee Industry in Vietnam

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Authors' contributions

This work was carried out in collaboration between all authors. Author LTTL designed the study, conducted data and performed the statistical analysis. Authors IMP, SPC and ZMS advised and managed the analyses of the study. Authors IMP, SPC and ZMS managed the literature searches and edited the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

Bac Giang province, Vietnam has potential for growing lychee. However, the price of lychee is low and unstable. Consumers are seeking higher quality lychee by accessing international standards and control systems. In order to improve the quality of lychee, Good Agricultural Practice (VietGAP) was implemented in Bac Giang province. This paper discusses the status of the lychee industry and evaluates the extent of and factors affecting adoption of VietGAP in lychee industry in the province. Results showed that the volume of lychee production of the province grew from 29,027 tons to 213,000 tons from 1997 to 2011. The prices of lychee were different across districts and depended on the lychee class and season. Fifty-six percent of VietGAP farmers who were considered high adopters were applying 8 or more of the prescribed practices; the rest were considered low adopters. The logit model showed that farm size, net profit, accessibility to VietGAP information, and membership in lychee farmers' group significantly influenced the probability of high

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adoption of VietGAP. The study recommended improving the VietGAP program implementation; providing greater access to capital, and better equipment and tools for lychee production; and encouraging membership to lychee farmers' group.

Keywords: Lychee production practices; VietGAP; adoption; extent and factors; logit model.

1. INTRODUCTION

Vietnamese fruit production has shown rapid growth since income per hectare from growing fruits are 4 to 8 times greater than from growing rice [1]. Lychee is one of the main fruits in Vietnam that include pomelo, dragon fruit, star apple, mango, durian, rambutan, longan and watermelon. Vietnam is one of the world's top five lychee producing countries after China, India, Taiwan, and Thailand [2]. It contributes significantly to the supply of lychee products in the world. Two provinces, namely, Bac Giang and Hai Duong are the main areas for producing lychee in Vietnam.

With lychee production of around 213,000 tons in 2011, Bac Giang is the largest lychee producing province. This province exported 69,565 tons of lychee to China and other countries such as Taiwan and Russia in 2011. The total export value was 890 billion VND[1] which indicated that Bac Giang has strong potential for growing and exporting lychee.

However, the price of lychee is very low and unstable. The exporters are the ones who have power to control the price [3]. Being the main importer of Vietnamese lychee, the preferences of Chinese consumers, particularly those in urban areas, have changed since China joined the WTO. Chinese consumers are seeking higher quality, clean and attractively packaged products. Similar trends are occurring in the Vietnam domestic market as national wealth grows. China and other developing nations have responded to this need for assurances by accessing international standards and leveraging domestic governmental standards and control systems [4]. The traders are willing to pay higher price for the lychee type which has better quality and appearance [3]. In order to improve the fruit quality, promote consumer safety, and increase production of high value export products, the Ministry of Agriculture and Rural Development (MARD) introduced Good Agricultural Practice (VietGAP). It was applied in the lychee industry in Bac Giang province as a pilot area. VietGAP consists of 12 practices covering four components including food safety; environmental management; workers' health; safety and welfare; and production quality [4]. This paper discusses the status of the lychee industry and evaluates the extent of and factors affecting adoption of VietGAP in the lychee industry in Bac Giang province, Vietnam.

2. METHODOLOGY

2.1 Sources of Data

The study area covered two major lychee districts in Bac Giang province, Vietnam, namely: Luc Ngan and Luc Nam. Luc Ngan has 52% of the total lychee planted area in Bac Giang province and adopted VietGAP. Luc Nam has approximately 20% of lychee planted area in the province and did not adopt VietGAP. Both primary and secondary data were used in this study. Primary data were collected by conducting a survey and personal interviews of the lychee farmers. Key informant interviews of the leaders of groups like cooperatives and other agencies/ organizations in the area were also conducted to gather relevant information. Secondary data were sourced from various government agencies and the internet.

Stratified random sampling was applied in choosing the farm samples. The number of respondents in Luc Ngan (43 farmers) and Luc Nam (57 farmers) was determined using the formula [5]:

$$n_i = \frac{NiZ^2Pi(1-Pi)}{Nid^2 + Z^2Pi(1-Pi)}$$

Where: n_i is the sample size in Luc Ngan and Luc Nam. Ni is the total number of farms in Luc Ngan (37,826 farms) and Luc Nam (44,373 farms). d is the maximum error deemed acceptable. In this study, 10% error was used for calculation of the sample size. Z is the normal variable. With 10% error, the normal variable is equal to 1.645. Proportion P_i is percentage of

[1] *1 USD = 20,000 VND (Currency exchange rate in 2011)*

lychee producers in Luc Ngan (80%) and Luc Nam (70%).

2.2 Analytical Tools

Descriptive analysis was done with the aid of tables and figures to analyze the status of the lychee industry in Bac Giang province, the adoption of VietGAP on lychee industry, the characteristics of VietGAP farmers and non-VietGAP farmers, and other relevant information.

To determine the factors affecting the extent of adoption innovations in agriculture, various models can apply in the economic literature. The research from rice production in Philippines employed Logit model and Poisson estimators to show the effect of socioeconomic, institutional and environmental factors influencing the adoption of certified seeds. The survey consisted of 3164 samples [6]. Other researchs considered Linear regression analysis to identify the factors that further affected the vegetable growers' adoption intensity of IPM practices [7] and to determine the extent of organic vegetable farming at farm household level [8]. These studies did not consider specific level of adoption The logit empirical model is as follows:

groups such as high adopters and low adopters groups.

The binary logit model was applied to determine the factors affecting the extent of adoption of VietGAP in lychee industry. In the logit model, extent of adoption of VietGAP (dependent variable) has 2 values: P = 1: if lychee farmer has high adoption of VietGAP and P= 0: if lychee farmer has low adoption of VietGAP. Since VietGAP has 12 practices, farmers who applied 8 practices or more (above 67%) were classified as high adopters of VietGAP. Those who adopted less than 8 practices (less than 67%) were low adopters of VietGAP.

The linear form of the logit function is: $Ln\{Pi/(1-Pi)\} = \alpha + \beta_i X_i + \varepsilon_i$. Where: i presents the individual i, and ε_i is error term.The parameters were estimated by maximum likelihood technique. The marginal effects of Xi on Pi were measured by taking the partial derivative of Pi with respect to Xi $(\partial P_i/\partial X_i)$. In logit model, marginal effect represents the change in probability as affected by a unit change in Xi, ceteris paribus.

$$Ln\{Pi/(1-Pi)\}=\alpha_0 + \alpha_1 Age + \alpha_2 Edu + \alpha_3 Fsize + \alpha_4 Netprofit + \beta_1 Dinfo + \beta_2 Dgroup + \varepsilon_i$$

Where: Pi is the probability of high adoption of VietGAP; α_0 is intercept; α_1, α_2, α_3, α_4 are coefficients of explanatory variables, namely, Age, Edu, Fsize, and Netprofit, respectively; β_1 is coefficient of accessibility to relevant information on VietGAP dummy variables; β_2 is coefficient of membership in the lychee farmers' group dummy variable; and ε_i is the error term. The independent variables are explained in Table 1.

3. RESULTS AND DISCUSSION

3.1 Status of the Lychee Industry

3.1.1 Production, planted area and yield

Lychee is one of the most demanding crops among tropical and subtropical fruit trees in terms of climatic condition.In Asia, China is the leading lychee-producing country in terms of volume of production. Its production covers 580,000 ha with output of 1,558,400 tons, over 66% of which has been developed in the past 10 years [9]. India is the second largest lychee producer with around 500,000 tons of lychee produced. Following India is Taiwan, the third largest lychee producer where about 100,000 tons of lychees are produced annually (Fig. 1).

Thailand produced 85,000 tons and is the fourth largest lychee producer [2,10]. Vietnam is the fifth largest producer where annual production is estimated at about 50,000 tons from 35,352 ha of planted area [11].

Table 1. The independent variables affecting extent of VietGAP adoption

Variable	Specification	Unit of measure
Age	Age of household head	Number of years
Edu	Educational attainment of farmers	Number of years in school
Fsize	Farm size	Hectares (ha)
Netprofit	Net profit of lychee farm at previous lychee season	1,000 VND
Dinfo	Accessibility to relevant information on VietGAP	1=Accessible, 0 = otherwise
Dgroup	Membership in the lychee farmers'group	1=Yes, 0 = otherwise

This model was estimated using the binary logit model analysis employing the stata software

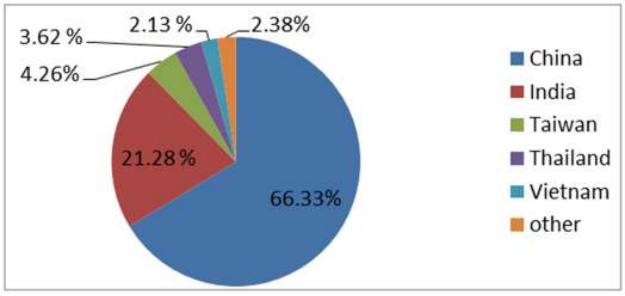

Fig. 1. Production shares of major lychee producers, 2000

In Vietnam, the climate of northern where winter is short, dry and a little bit cold and summer is long and hot with high rainfall and humidity, is quite suitable for the growth of lychee [11]. In the northern region, Hai Duong is considered as the original lychee province. After that, lychee has grown everywhere in the northern region. Specifically, Bac Giang has the biggest lychee commercial cultivation.

As shown in Table 2, the lychee planted area in Bac Giang province fluctuated in the period 2004 – 2011. The lychee planted area in Bac Giang province increased from 18,000 ha in year 2004 to 35,878 ha in year 2011. It reached 37% and 41% of total lychee planted area in Vietnam in 2004 and 2011, respectively. In Thanh Ha district, Hai Duong province, planted area decreased slightly between 2004 and 2011. It had 14% of the total lychee planted area and 17% of total lychee production in Vietnam in 2004. However, these shares decreased to only 8% and 6%, respectively, in 2010.

Be considered as the biggest lychee producer in Vietnam, the specifc planted area, production, and yield of lychee in the districts of Bac Giang province in 2011 are shown in Table 3.

Luc Ngan district had the largest lychee planted area with 18,500 ha, followed by Luc Nam with 6,140 ha. Their shares in area planted are 52% and 17%, respectively. The total lychee production of Bac Giang province in 2011 was 206,861 tons of which 58% and 17% were contributed by Luc Ngan and Luc Nam, respectively.

The yield of lychee differed across districts in Bac Giang province in 2011. Two districts, namely, Luc Ngan and Luc Nam, had the highest lychee yield per hectare of 6.5 tons and 5.82 tons, respectively. The average yield of lychee of Bac Giang province was 5.77 tons per hectare.

3.1.2 Prices

There were two main lychee varieties in Bac Giang province, namely, the pre – ripened lychee and the Thieu lychee. The price of pre-ripened lychee was greater than Thieu lychee's price during the main season (Table 4).

Additionally, the price of lychee declined from the beginning of the season to the end of the season for both varieties. This can be explained by the law of supply and demand. When the supply of lychee is greater than the demand, certainly the price of lychee will decrease during the main season. The difference between the average prices of the pre-ripened lychee and the Thieu lychee was more than 3,000 VND. The prices in Luc Ngan district were not so different from those of other districts. Even the average price of pre-ripened lychee was almost the same as the prices in other districts, around 15,000 VND.

However, the price of Thieu lychee was very high in Luc Ngan district with an average of 12,000 VND compared to the price of lychee in other districts which only was 5,000 to 7,000 VND.

Fig. 2 shows that there were also differences in the prices of lychee across districts in Bac Giang province at the end of the season. The lowest price was in Yen Dung and Viet Yen districts at 2,000 VND per kg of lychee. On the other hand, Luc Ngan was not only able to maintain a high price for lychee but was also able to keep a stable lychee price from beginning up to the end of the season. This is because Luc Ngan has been applying VietGAP's cultivation techniques in lychee production since 2008.

Table 2. Planted area and production of lychee, Bac Giang province and Thanh Ha district (Hai Duong province), Vietnam, 2004 – 2011

Item	2004	2006	2008	2009	2010	2011
Lychee planted area (ha)						
Bac Giang	18,000 (37)[a]	26,000 (42)	39,000 (45)	37,081	36,900 (41)	35,878
Thanh Ha	6,596 (14)	6,744 (11)	5,900 (7)	6,000	7,000 (8)	6,500
Vietnam	48,650 (100)	62,000 (100)	86,900 (100)	-	90,000 (100)	-
Lychee production (tons)						
Bac Giang	100,000 (78)	104,000 (78)	220,000	127,796	177,500 (81)	213,000
Thanh Ha	22,000 (17)	20,168 (15)	27,000	18,000	13,000 (6)	25,000
Vietnam	128,000 (100)	133,500 (100)	-	-	220,000 (100)	-

[a]*Figures in parentheses refer to percentage of total lychee planted area and total lychee production in Vietnam, Source: [12,13]*

Table 3. Planted area, production and yield of lychee, Bac Giang province, Vietnam, 2011

District	Area (ha)	Production (tons)	Yield (tons/ha)
Bac Giang City	120	577	4.81
Luc Ngan	18,500	120,250	6.5
Luc Nam	6,140	35,735	5.82
Son Dong	2,205	7,166	3.25
Yen The	4,068	22,903	5.63
Hiep Hoa	620	1,699	2.74
Lang Giang	1,507	7,264	4.82
Tan Yen	1,700	7,939	4.67
Viet Yen	123	437	3.55
Yen Dung	895	2,891	3.23
All/ Average	35,878	206,861	5.77

Source: [12,13]

Table 4. Price of lychee by variety and season, Bac Giang province, Vietnam, 2011

Price of Pre-ripened lychee (1,000 VND/Kg)				Price of Thieu lychee (1,000 VND/Kg)			
Average	**Beginning**	**Mid-season**	**End**	**Average**	**Beginning**	**Mid-season**	**End**
-	-	-	-	7.0	9.0	7.0	5.0
15.0	16.0	14.0	15.0	12.0	14.0	8.0	14.0
12.6	16.0	13.0	9.0	7.0	10.0	7.0	4.0
-	-	-	-	5.0	7.0	5.0	3.0
12.0	17.0	12.0	7.0	7.0	10.0	7.0	4.0
-	-	-	-	5.0	6.0	4.0	5.0
13.0	18.0	12.0	9.0	6.0	8.0	6.0	4.0
18.0	22.0	15.0	17.0	6.0	8.0	6.0	4.0
-	-	-	-	4.0	6.0	4.0	2.0
-	-	-	-	4.0	6.0	4.0	2.0
14.12	17.8	13.2	11.4	6.3	8.4	5.8	4.7

Source: [13]

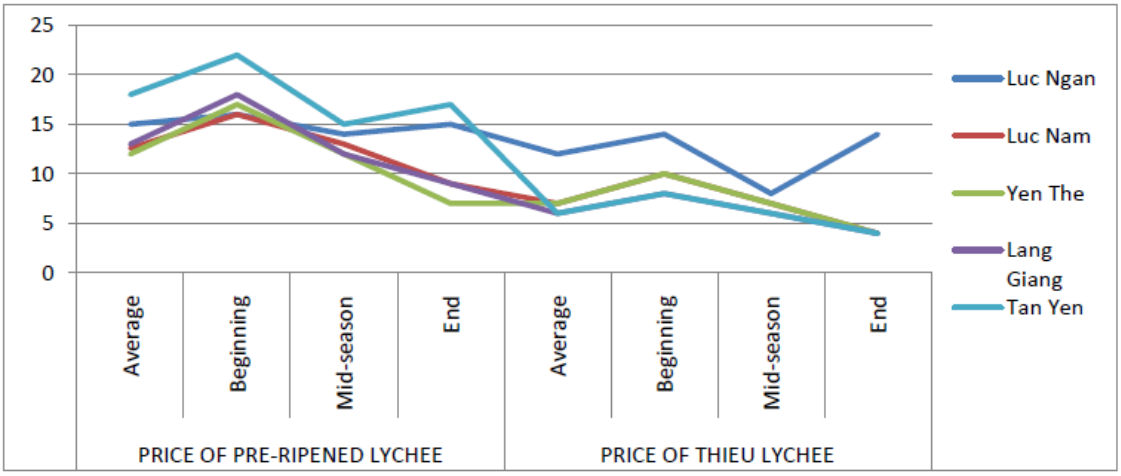

Fig. 2. Average prices of lychee (1,000 VND/kg) by district and season in Bac Giang province, Vietnam, 2011

Source of basic data: Table 4

According to Lan (2010), the lychee produced with the application of VietGAP has not only good appearance and better uniformity but is also chemical residue free [3]. This is the reason why lychee collectors from China or even from domestic markets always choose Luc Ngan as first priority in sourcing lychee.

3.1.3 Marketing channels

The value chain of fresh lychee in Thanh Ha district, Hai Duong province indicates that around 2% of lychee produced in this area were sold in Chinese markets, 80% to the southern provinces and Cambodian markets, and 18% went to the northern provinces like Hai Duong, Hai Phong, Hanoi, and others [12]. However, there were differences in markets and market segmentations between Thanh Ha district and Bac Giang province. In Luc Ngan district, Bac Giang province, 48% of fresh lychees were consumed domestically and 52% were sold to China [3]. The product of this channel is the first class lychee which has better quality and appearance than that produced in other places and the price is usually higher than those of other lychee types by around 3,000 VND. Outside traders from Lao Cai province play an important role in the operation of this channel. They come to the trading centers and directly participate in the chain to select and buy lychee from the farm households or local collectors.

The total volume of lychee in Bac Giang province for export reached 69,565 tons in 2011 [13]. This amount was equal to 32.6% of the total volume of lychee production in Bac Giang equivalent to a total export value of 890 billion VND. Ha Khau port and Kim Thanh port in Lao Cai province are major exit ports for lychee export. The volume of lychee export through these ports was around 38,230 tons. Export volume in Tan Thanh port in Lang Son province was around 31,335 tons. However, the domestic markets also play a very important role. Trade was around 91,935 tons or 43.2% of total lychee production in Bac Giang which were sold in the fruit stores and local markets. Around 51,546 tons or 24.2% of total lychee production in Bac Giang were sold in the supermarkets.

3.2 Socio – Economic Characteristics of Lychee Farmers

Table 5 compares the characteristics of the selected farmer – respondents from Luc Ngan and Luc Nam districts. The farmer – respondents were relatively homogenous in terms of demographic characteristics.

The mean age of the non- VietGAP respondents was 47.12 years while it was 46.67 years for VietGAP farmers. The difference in age between the two groups was not significant. In terms of educational attainment, VietGAP farmers spent more years in school than the non – VietGAP farmers, with the difference being significant at 10% probability level. The average lychee farm size was 0.6 hectare in Luc Ngan district and 0.51 hectare in Luc Nam district but the difference was not significant. However, there was a significant difference at 1% level in the

density of lychee trees per hectare in Luc Ngan and Luc Nam districts. The lychee yields are 13,638 kg per hectare and 12,550 kg per hectare in Luc Ngan and Luc Nam districts, respectively, with the difference being significant at 1% of probability level. Lychee is the main crop in Bac Giang province. It contributed quite highly to the farmers' income. The average income contributions of lychee production were approximately 80% and 55% of the total household income in Luc Ngan and Luc Nam districts, respectively.

3.3 Production, Post harvest and Marketing Practices in Lychee

The practices for lychee industry were significantly different between VietGAP farmers and non-VietGAP farmers. In lychee production, the VietGAP farmers decided to graft more pre-ripened variety trees to avoid the risk of lychee price in the peak season. Whereas the non – VietGAP farmers said this was not easy to care for the grafted branches. Thus, only a small number of non – VietGAP farmers were planting this variety. The densities of trees were also different between two farmers' group. According to the VietGAP farmers, they could focus on creating canopy and pruning with lower density of trees. It is a reason why they practiced pruning after harvest and spent more man day for pruning. This was also different in fertilizer and pesticide application practices between two groups about the time, the amount, and the method application, the application recording, and the protective clothing using. Specifically details were shown in the Table 6.

Table 7 showed the comparisons in harvest, post harvest and marketing practices for lychee between non – VietGAP farmers and VietGAP farmers. The significant difference was the factors affecting the farmer's decisions in harvesting. The non-VietGAP farmers decided the time to harvest based on the demand from the market. However, the VietGAP farmers decided based on the fruit quality. Additionally, the VietGAP farmers used canvas to cover the orchard land during harvesting time to keep the picked fruits clean. They had some contracts with supermarkets and the lychee collectors marked lychee from VietGAP farmers as first class lychees.

3.4 Extent of Adoption of VietGAP

Forty-three respondents who applied VietGAP practices on lychee production in Luc Ngan district were interviewed. Table 8 shows that all of the respondents satisfied the soil and water requirement of VietGAP. Harvesting and storage and transport were the second mostly adopted practices with around 95% of total adopters. Chemical pesticide application was highly adopted as well with 93% of total adopters followed by waste management and treatment and fertilizer application with around 91% and 88% of total adopters, respectively.

Adoption for selection of variety was lower with 31 adopters or 72% of total adopters since the farmers who followed the practice of grafting pre-ripened lychee said this was quite difficult to adopt.

Table 5. Characteristics of VietGAP lychee farmers and non – VietGAP lychee farmers in Bac Giang province, Vietnam, 2011

Characteristics	VietGAP (A)	Non-VietGAP (B)	Overall	Difference (A - B)
Number of respondents	43	57	100	
Age of household head (years)	46.67	47.12	46.93	-0.45^{NS}
Education attainment (years)	7.6	6.28	6.85	1.32*
Household size (persons)	4.72	5.23	5.01	-0.51^{NS}
Lychee farm size (hectares)	0.6	0.51	0.55	0.09^{NS}
Density (trees per hectare)	288	326	310	-38***
Lychee productivity (kg per hectare)	13,638	12,550	13,018	1,088***
Percentage income contribution from lychee industry (%)	80	55	65	25^{NS}

Note: (***) and (*) are significant at 1%, 10%, respectively. NS is not significant at 10% probability level, Source: primary survey, 2011

Table 6. VietGAP and Non – VietGAP farmers' practices in lychee production in Bac Giang province, Vietnam, 2011

Practice	Non – VietGAP farmers	VietGAP farmers
Lychee varieties	Proportion of pre-ripened variety in total lychee tree:18.5%. Average density: 326 trees/hectare	Proportion of pre-ripened variety in total lychee tree:35%. Average density:288 trees/hectare (supported by VietGAP in grafting other varieties)
Creating canopy and pruning	Pruned branches late (2 or 3 months after harvest), pruned once a year. Spent 18 man days for pruning.	Pruning after harvest, once a year. However, the farmers usually visited the orchard and started pruning disease branches immediately once they find signs of diseases. Spent 31.09 man days for pruning
Fertilizer application	Fertilized in early October. Fertilized based on 50% experience of farmers and 42% practice of the neighbors, 8% followed the instruction from the fertilizer seller and extension officers. Applied 1,850 kg composted manure, 50 kg nitrogen, 300 kg phosphorous, and 100 kg potassium per hectare. Although the farmers have known that applying more potassium will increase lychee productivity they only applied 0.3 kg per tree. According to them, higher lychee productivity would mean lower lychee price. All of the respondents did not record the details of fertilizer application, application rate, method of application, and price of fertilizer used.	Fertilized in early in August (after pruning) Fertilized based on 85% their experiences combined with guidelines from VietGAP program, 15% of the VietGAP farmers decided confidently on the volume of fertilizer and pesticide applied in their lychee orchards. Applied 1500 kg, 85.43 kg, 547.5 kg, and 285 kg for composted manure, nitrogen, phosphorus, and potassium, respectively per hectare. Around 88% of VietGAP respondents recorded their fertilizer application methods. Records included the prices of fertilizers, the time of applying fertilizer, and some other details worthy of notes for the information of the extension officers.
Pesticide application	Applied once a year. Consulted their neighbors and chemical sellers on how to apply pesticides. Average volume of chemical application on lychee: 45 liters. Used 30.7 man days of labor for pesticide application. Did not keep record regarding their pesticide application. The farmers used face covers but they did not usually use gloves or hats since they said the lychee trees in Luc Nam are shorter than those in other districts.	Applied once a year. Consulted and adhered to the VietGAP guidelines in applying chemical pesticide. Average volume of chemical application on lychee: 42.72 liters. Aside from similar pesticides that were applied in Luc Nam district, farmers also sprayed Ethrel several times to support the pre – ripened variety. Used an average of 43.22 man days for chemical application. Recorded all details related to this practice. Face covers, hats, and gloves were popular clothings used. However, they did not use protective glasses during chemical pesticide application (spraying) for lychee.

Source: Primary data, 2011

Pruning and documentation and recording had the same proportions of adopters at 42%. Not all of the respondents were confident with their pruning experiences. Some of them did not even practice pruning immediately after harvest. The farmers took note of their practices but some of them had no regular recording.

Complaint and complaint resolution and safety for workers were least adopted with only 28% and 23% of total adopters, respectively. The farmers reported their complaints via extension workers and the lychee group although the number of reports was not so many. On the workers' safety, the VietGAP farmers

understood the adverse effect of chemical pesticide to them and their community. This is the reason why they ensured that the time for harvesting was at least 15 days after chemical application. Nonetheless, they ignored the bad effect of chemical on their eyes. That is why none of them wore protective glasses. Remarkably, no farmer adopted the internal audit requirement. According to them, this practice was not important in their lychee production.

Table 9 shows the extent of VietGAP adoption in lychee by range of practices adopted. Among the 43 VietGAP adopters, 24 adopters applied 8 practices and above, or 56% of total respondents, while 19 farmers adopted less than 8 practices, or 44% of total respondents.

All respondents said they got more advantages when the extension workers and lychee group members supported them in their practice of VietGAP recommendations. This is the reason why all of them applied at least 6 practices. Ten is the highest number of VietGAP practices adopted in the survey area. Two farmers out of 43 respondents applied 10 practices. Two of them believed that lychee is a potential

Table 7. Harvest, post harvest and marketing practices for lychee industry in Bac Giang province, Vietnam, 2011

Non – VietGAP farmers	VietGAP farmers
Harvested lychee as soon as possible or whenever they found there is a demand from the market. The farmers ignored the safe period after chemical application and focused more on the profit. The high demand for lychee fruit will always convince the farmers to harvest lychee. This decision also has advantage in terms of avoiding risk of lower price during the peak season. Some traditional tools such as sickle, bamboo frame, bamboo chair, and bamboo basket were still being used for lychee harvest. Lychee was sorted by shape and weight. The average weight of lychee bundles was around 1 to 2 kg. The producers brought the sorted fresh lychee to the collection station near their villages by motorbike.	The color and size of lychee were most important factors affecting the farmer's decisions in harvesting. Based on their experiences, they knew when to harvest lychee with good quality or fruit ripening level. The farmers still used poor equipment to pick lychee such as sickle, bamboo frame, bamboo chair, and bamboo basket. Aside from the equipment, the farmers also used canvas to cover the orchard land during harvesting time. The canvas, a support from VietGAP, could keep the picked fruits clean. Lychee was then sorted by color, shape, and weight. The average weight of lychee bundles was around 1 to 2 kg. 20% of VietGAP producers (9 respondents) had contracts with some supermarkets in Hanoi.

Source: Primary data, 2011

Table 8. Extent of VietGAP adoption in lychee by practice, Luc Ngan, Bac Giang, Vietnam, 2011

	VietGAP practice	Adoption	
		Number reporting[a]	Percent
1	Soil and water	43	100
2	Varieties	31	72
3	Pruning	18	42
4	Fertilizer application	38	88
5	Chemical application	40	93
6	Harvesting	41	95
7	Storage and transport	41	95
8	Waste management and treatment	39	91
9	Safety for workers	10	23
10	Documentation and recording	18	42
11	Internal audit	0	0
12	Complaint and resolution of complaint	12	28

[a] *Multiple responses, Source: Primary data, 2011*

perennial crop in the local area. And this is a motivation for them to learn the new technology and share experiences with other farmers.

3.5 Factors Affecting Adoption of VietGAP

Binary logit analysis was done to determine the factors influencing the extent of adoption of VietGAP in lychee industry. The dependent variable was defined as the rank in terms of extent of adoption based on the rate of practices used. A likelihood ratio test was made to measure the goodness of fit of the model. The likelihood ratio was found highly significant. This implies that the rate of adoption of VietGAP in lychee industry was explained by the explanatory variables included in the model. The results of logit estimation are shown in Table 10.

Among the explanatory variables considered, farm size, net profit in 2010 operation, accessibility to information, and membership to a lychee farmers'group significantly influenced the extent of VietGAPadoption in the lychee industry of Bac Giang province.

The results of the marginal effect estimation also shown in Table 10 indicate that a 1 hectare increase in farm sizewill decrease the probability of high adoption of VietGAP by 1.21.Farmers who have bigger farms are less likely to adopt VietGAP. The reason for this significant effect is that VietGAP involves strict implementation of practices, which could also mean requiring farmers to add more capital and employ more laborers in the lychee farming operations. A 1,000VND increase in net profit of lychee production last season (2010) would increase the probability of high adoption of VietGAP by0.02.Lychee farmers who had more income or net profit from previous lychee season were more inclined to adopt VietGAP. With higher income, they have more capital to finance the required farming operation for the next season.

Table 9. Extent of VietGAP adoption in lychee by range of practices adopted, Luc Ngan, Bac Giang, Vietnam, 2011

Range of practices	Adoption	
	Number reporting	Percent
0-5	0	0
6	10	23
7	9	21
8	11	25.6
9	11	25.6
10	2	4.6
11-12	0	0
High adoption[a]	24	56
Low adoption[b]	19	44
All	43	100

[a] Adopted 8 practices and above, [b] Adopted less than 8 practices

Table 10. Logit estimates of factors affecting adoption of VietGAP in lychee industry, Luc Ngan, Bac Giang province, Vietnam, 2011

Variable	Coefficient	Z – test	ME (dy/dx)	Z - test
Intercept	-1.3934	-0.22	-	-
Age	-0.1250	-1.13	-0.0214	-1.06
Edu	0.0659	0.25	0.0113	0.25
Farm size	-7.0730**	-2.02	-1.2149**	-2.06
Net profit	0.0001***	2.58	0.00002***	2.85
Accessibility to information	3.7766**	2.07	0.7348***	3.32
Membership in lychee farmers' group	5.6809***	2.69	0.6061 ***	3.72
LR chi2(6) = 34.33			Log likelihood = -12.067	
Prob > chi2 = 0.0000			Pseudo R2 = 0.5872	

*Note: ** and ***: significant at 5% and 1%, respectively*

If the farmers have access to relevant information on VietGAP, the probability of high adoption of VietGAP will increase by 0.73. The positive effect of accessibility to VietGAP information would suggest the VietGAP program opening more training for farmers and extension officers. Information is very important for the farmers since they still have difficulties during applying VietGAP. Similarly, if they are members of the lychee farmers' group, the probability of adoption will increase by 0.6.The farmer will more likely adopt VietGAP if he is a member of a lychee farmers' group. This could have been due to the fact that lychee group members were priority participants of related trainings and workshops where they share experiences on lychee production. The age and educational attainment of the household head were found to have positive although not significant influence on the extent of adoption of VietGAP in the lychee industry.

4. CONCLUSION

The study applied the binary logit model to determine the factors affecting the extent of adoption of VietGAP lychee industry in Bac Giang, Vietnam. The factors that significantly influenced the extent of VietGAP adoption in the lychee industry are farm size, net profit in previous lychee season, accessibility to information, and membership to a lychee farmers' group. In order to encourage lychee farmers to adopt full practices, the study recommended: 1) improving the VietGAP program implementation; 2) providing more training for farmers and extension workers, processing support, insurance fund, greater access to capital, and better equipment and tools for lychee production; 3) and encouraging membership to lychee farmers' group.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Chien TM. On the study of critical points in the lychee supply chain. The case of Bac Giang, Vietnam. Master of Science in Engineering in Agri-Chain Management; 2003. (Unpublished thesis).Vietnamese.
2. Evans EA, Degner RL. Recent developments in world production and trade of lychee: Implications for Florida growers. Proc. Fla. State Hort. Soc. 118:247-249; 2005.
Available:http://www.crec.ifas.ufl.edu/academics/faculty/burns/pdf/247-249.pdf
3. Lan NTP. Fresh Thieu lychee quality improvement for the upper segment of the markets base on chain analysis approaches. A Research project Proposal submitted to Larnstein University, The Netherlands; 2010. (Unpublished thesis).
4. Vong NQ. Good agricultural practices for Vietnamese fresh fruit and vegetables producers – Process of development. Proceedings of Good Agricultural Practice Workshop. Binh Thuan, Vietnam; 2008.
5. Reyes MZ. Social Research: A Deductice Approach, RBSI Philippines; 2004.
6. Marc Jim Mariano, Renato Villano, Euan Fleming. Factors influencing farmers' adoption of modern rice technologies and good management practices in the Philippines. Agricultural Systems. 2012; 110:41-53.
7. Muhammad Humayun Kabir, Ruslan Rainis. Adoption of intensity of integrated pest management (IPM) vegetable farming in Bangladesh: An approach to sustainable agricultural development. Journal of Environ Dev Sustain; 2014.
DOI 10.1007/s10668-014-9813-y
8. Gopal B Thapa, Kanoporn Rattanasuteerakul. Adoption and extent of organic vegetable farming in Mahasarakham province, Thailand. Applied Geography; 2010.
DOI: 10.1016/j.apgeog.2010.04.004
9. Chen Houbin. The production and uses of litchis in China. South China Agricultural University; 2004.
Available:http://www.gmup.org/presentation%20pdf/day1Chen.pdf
10. FAO. Lychee production in Asia Pacific region, Regional Office for Asia and the Pacific; 2002.
Available:http://www.fao.org/docrep/005/ac684e/ac684e04.htm

11. Ton VD, Huyen NTT. Activity of agents in lychee commodity chain in Thanh Ha district. Agricultural Publishing, Hanoi, Vietnam; 2006. Vietnamese.
12. Tru NA. The value chain analysis of lychee in Hai Duong province, Vietnam. MSc Thesis. University of the Philippines Losbanos; 2008. (Unpublised thesis).
13. Bac Giang Agricultural Office. Lychee marketing channel in Bac Giang 2006-2011. Vietnamese.

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